NEMS as a policy analysis tool

ORNL/Georgia Tech Working Meeting:
NEMS Capacity for Energy End-Use Analysis

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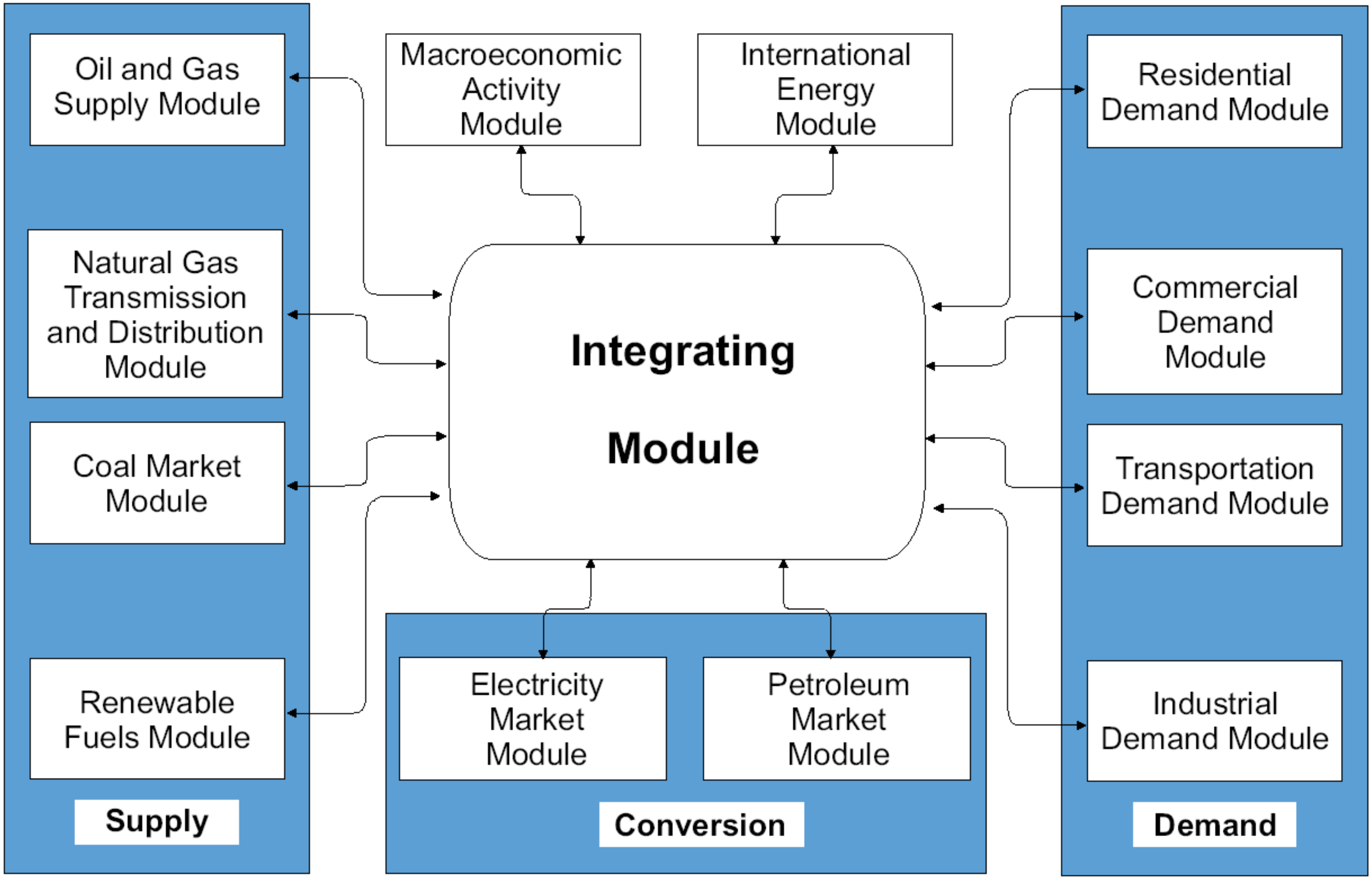
Overview

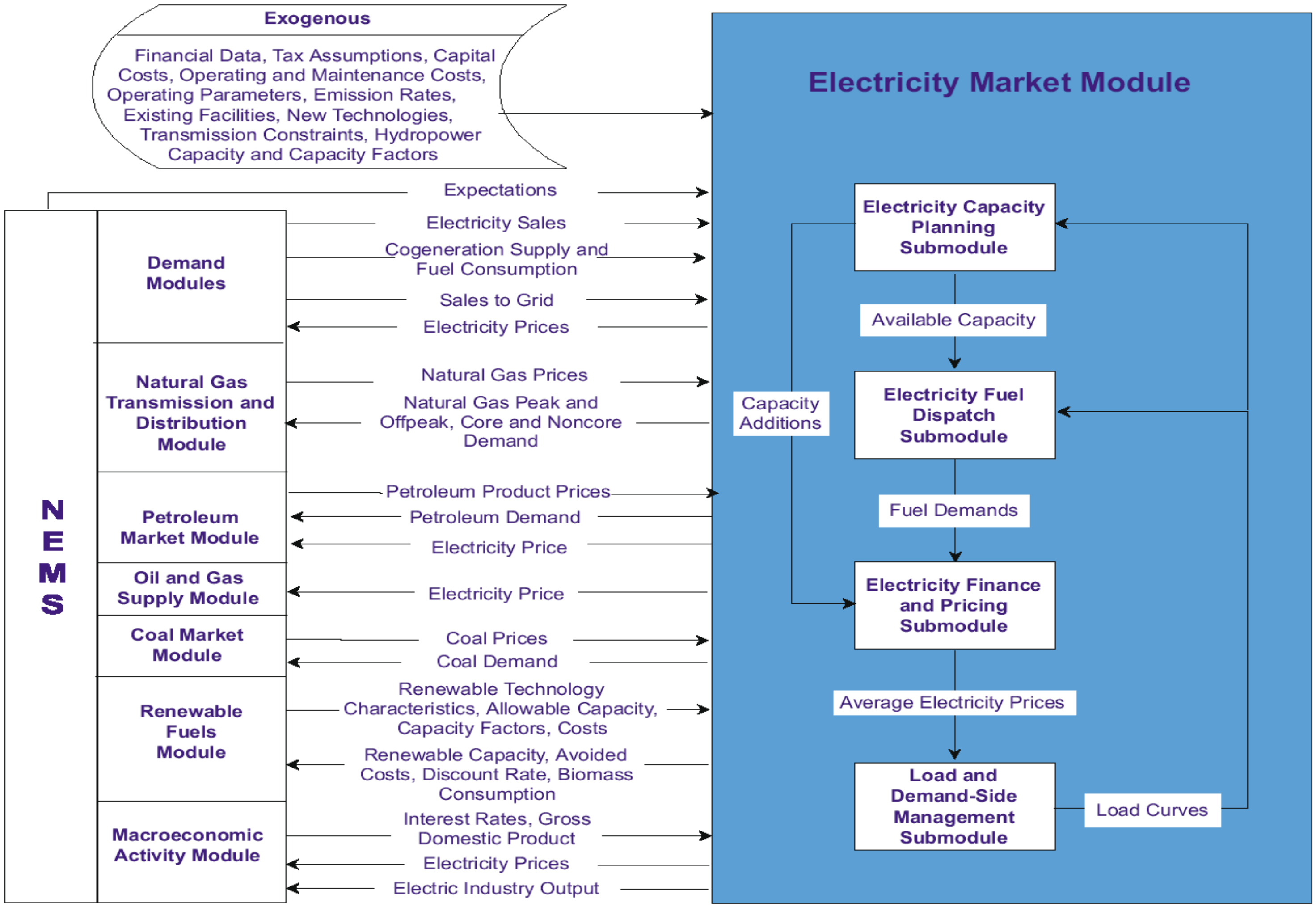
- NEMS Overview
- Load Curve Development in NEMS
- Policy analysis using NEMS – the big picture
- End-use policy in the AEO2013 Reference case
- End-use analysis capabilities in the NEMS buildings sectors

National Energy Modeling System



Sources: EIA

Electricity market module

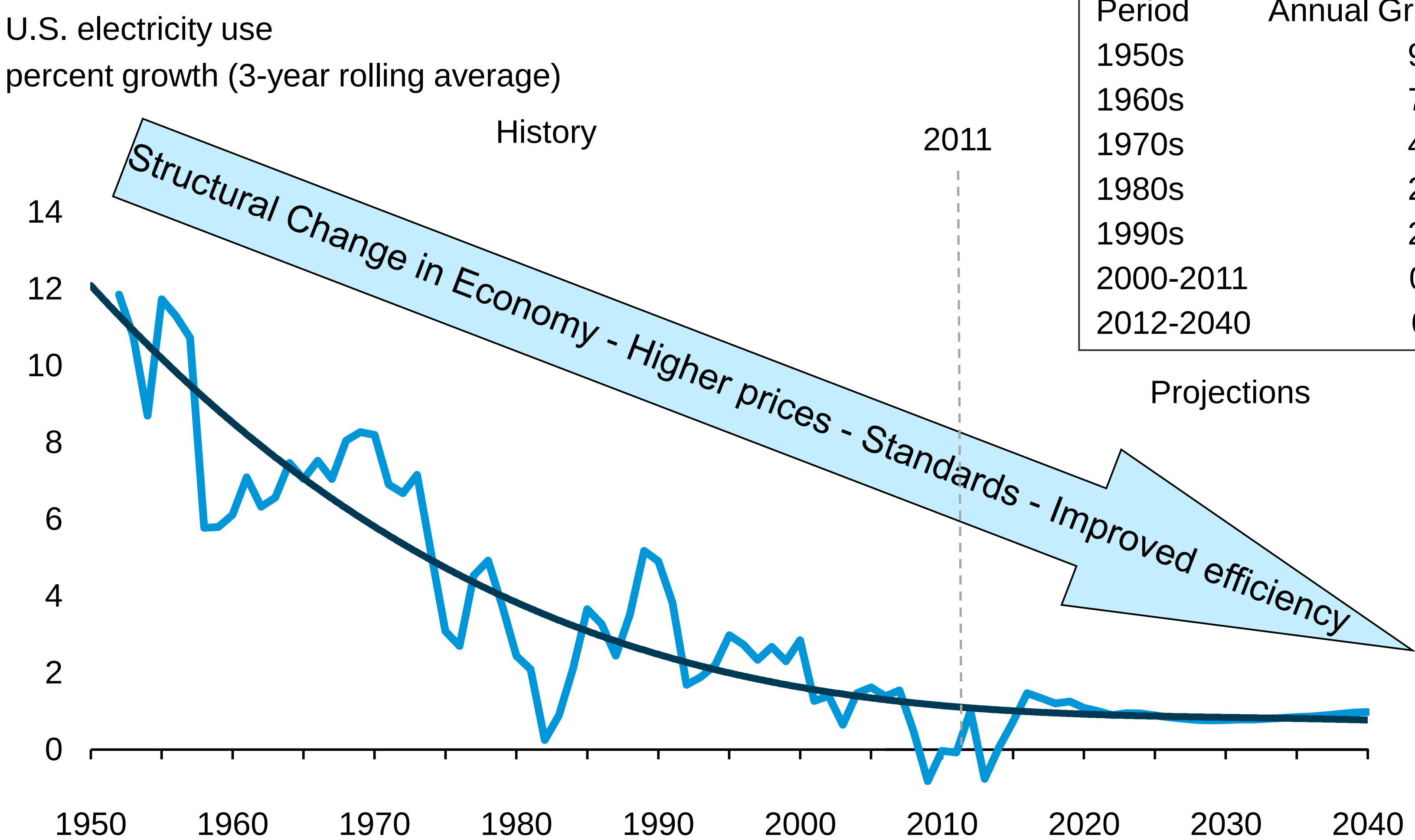


Sources: EIA

Electricity Load Curve Development in NEMS

Starting Curve	Derive delta adjustment			Final Curve
Weather normalized regional system load curves based on 2006-2010 data with 864 time slices (24 hours X 3 day types X 12 months)	25 different end-use demands from residential, commercial, industrial and transportation models passed each year	Change in each end-use demand from base year is calculated	End-use demand “deltas” are mapped into 864 load curve slices	Apply “deltas” to system load curves to get adjusted system curves and aggregate to 9 time slices use in the model

Growth in electricity use slows, but still increases by 28% from 2012 to 2040



Period	Annual Growth
1950s	9.8
1960s	7.3
1970s	4.7
1980s	2.9
1990s	2.4
2000-2011	0.9
2012-2040	0.9

Source: EIA, Annual Energy Outlook 2013 Early Release

Policy Analysis with NEMS

Renewable Fuels Standards

Production Tax Credits

Appliance Efficiency Standards Standards

Greenhouse Gas Cap and Trade Programs or GHG Fee Programs

Renewable / Clean Energy Portfolio Standards

Investment Tax Credits

Corporate Average Fuel Economy Standards

Reference case end-use policy assumptions

NEMS policy representation from the end-use perspective

- Policy assumptions are implemented in all four NEMS end-use modules
  - Residential, commercial, industrial, and transportation
  - Alternative assumptions allow for policy analysis
- Current legislation & regulations directly represented
  - Energy efficiency codes & standards and incentives for renewable technologies
  - Industrial boiler MACT rulemaking and California cap-and-trade program
  - Light-duty and heavy-duty vehicle standards
- Policies represented in other sectors affect end-use demand
  - Renewable portfolio standards, renewable fuel standards
  - Regulations on emissions
  - Incentives

Buildings policy representation

- Equipment standards
  - Promulgated federal standards
  - Consensus agreements
- Building codes
  - States assumed to meet goals defined in ARRA by 2018
    - Residential: IECC 2009 or better
    - Commercial: ASHRAE 90.1-2007 or better
- Distributed generation and end-use renewable technologies
  - Investment tax credits for renewable technologies and combined heat and power (CHP) are modeled with 2016 expiration as specified in current law
  - Interconnection limitations for distributed generation (DG) decline over time

Industrial policy representation

- Investment tax credit for combined heat and power
- Motor efficiency standards
- Boiler Maximum Achievable Control Technology (MACT)
- California AB32 (GHG Cap & Trade)

Transportation policy representation

- Tax credits for plug-in electric vehicles
- Light-duty vehicle GHG and CAFE standards, including credits
- Heavy-duty vehicle fuel efficiency and GHG standards
- Fleet alternative-fuel vehicle minimum sales requirement

End-use analysis capabilities in the NEMS buildings sectors

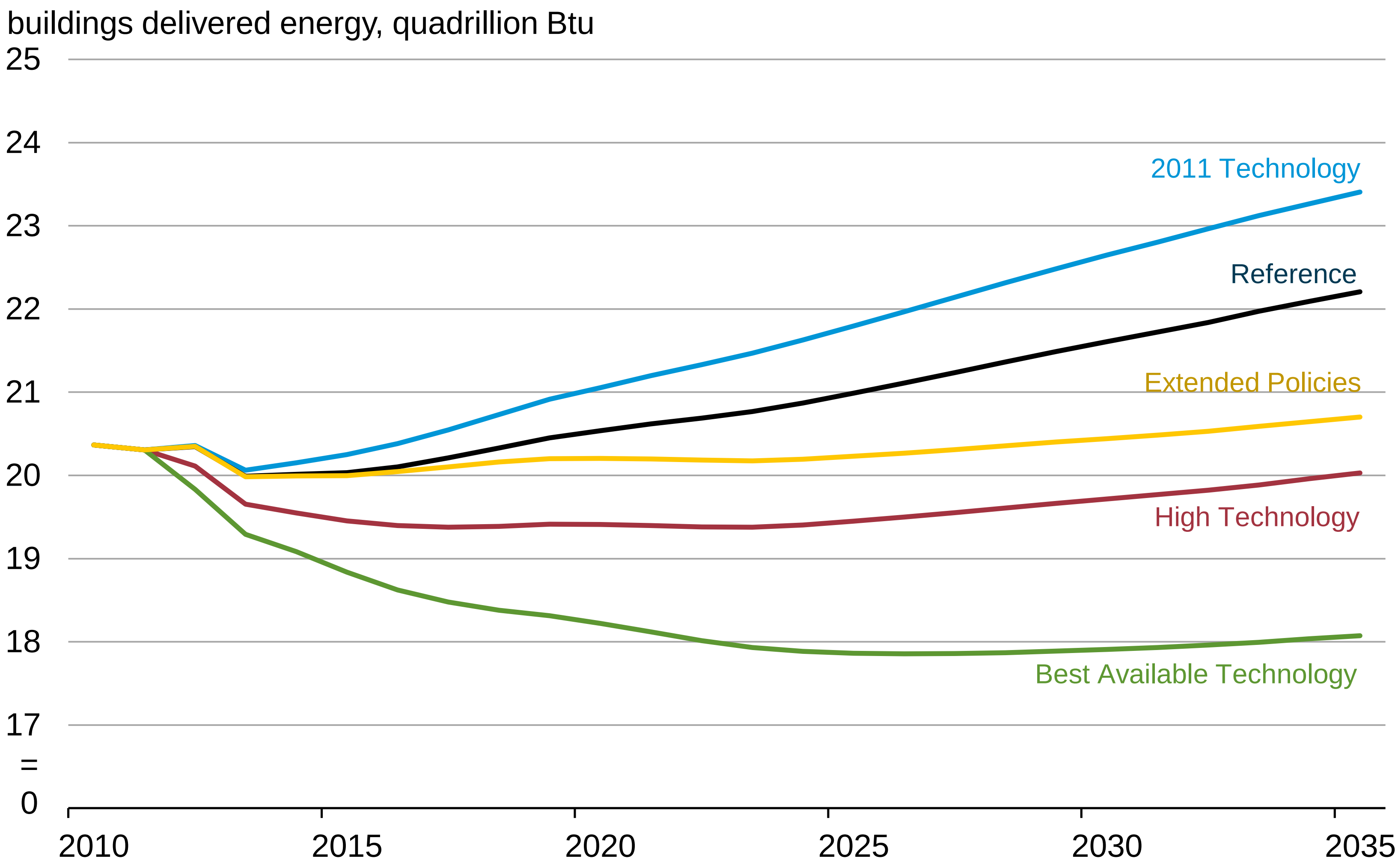
Many buildings assumptions can be changed for policy analysis through input files

- Degree day projections
- End-use technology characterizations
  - cost, performance, and availability parameters
  - additional technologies
- Residential shell parameters for new construction
- DG and CHP parameters
  - cost, performance, financing , and penetration parameters
  - tax incentives and depreciation treatment
  - RPS participation (in conjunction with power sector parameters)
  - program-driven installations
- Hurdle rates and technology/fuel switching propensity

NEMS buildings technologies have the opportunity to “learn” in four ways

- Learning for conventional technologies is exogenously specified by technology “menus” that include availability of cost and performance improvements over time
- Costs for less mature technologies can decline from menu costs over time based on parameters for the total anticipated price reduction, and the rate of price decline
- Menu availability of technologies can be accelerated with a sustained substantial increase in fuel prices
- CHP and distributed generation include potential for endogenous “learning” with declining technology costs as shipments increase in addition to menu-driven improvement

AEO2012 demand technology and analysis cases look at the impacts of alternative technology assumptions

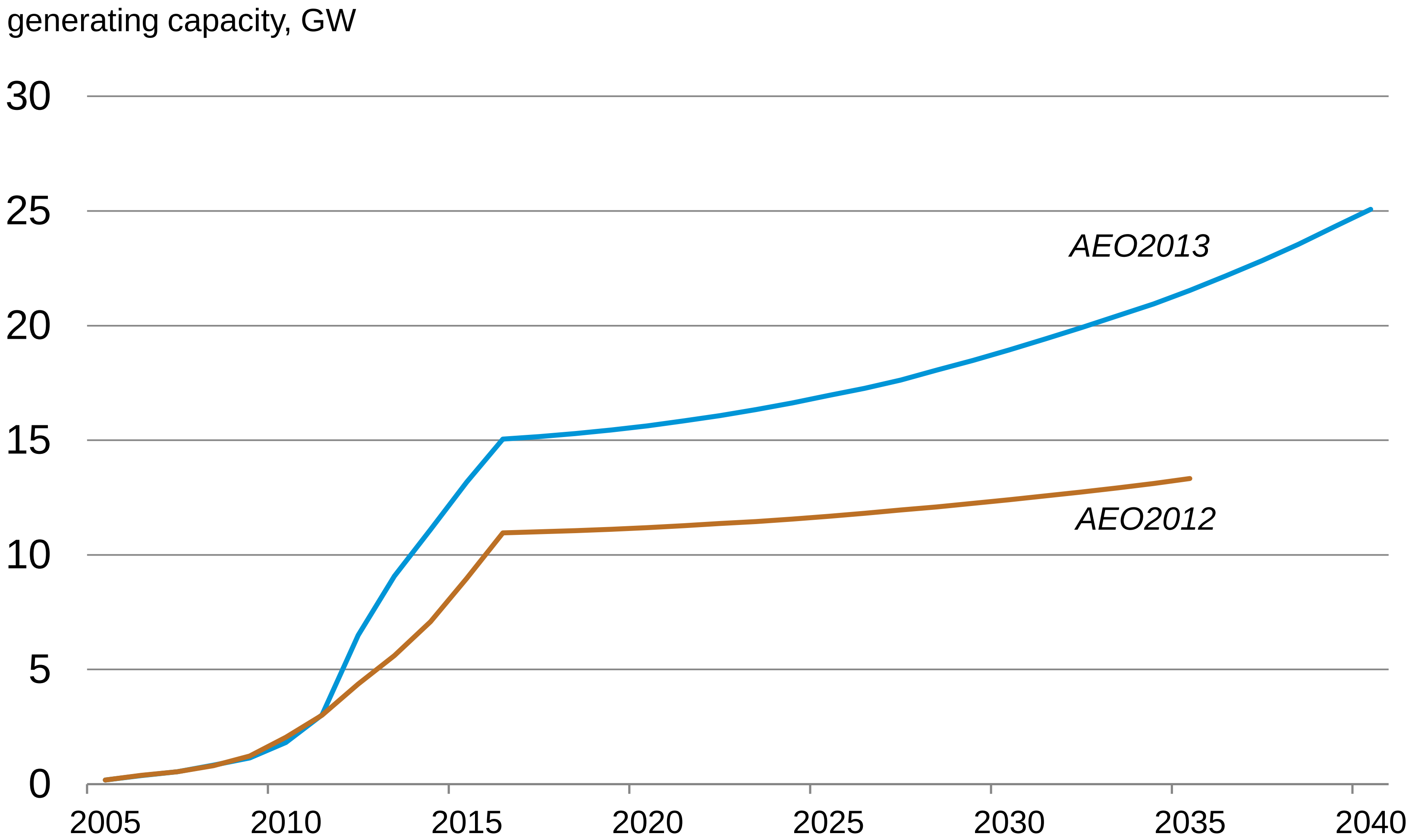


Source: Annual Energy Outlook 2012

AEO2013 includes updated DG parameters to better reflect recent trends

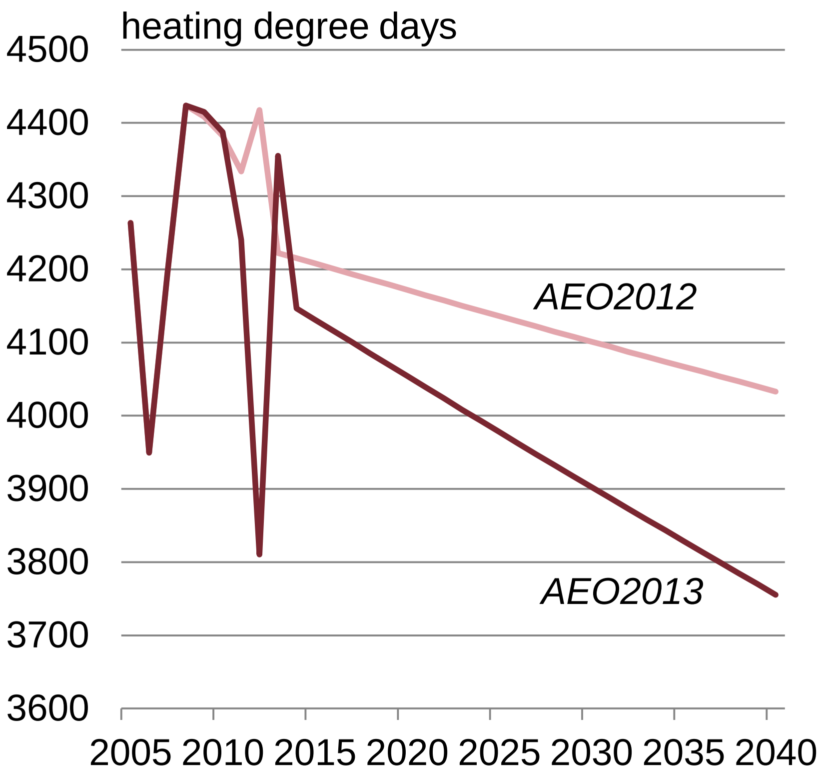
- Photovoltaic (PV) system menu costs have been updated
  - 2010 system costs now based on Tracking the Sun IV (LBNL, 2011)
  - reduced future costs based on NREL bottom-up potential costs although 2020 costs not directly incorporated
- Residential systems now require 8 years of positive cash flow
- Penetration limit into existing commercial floorspace has increased to one-tenth of penetration into new construction (overall cap of 0.5% of existing floorspace/year unchanged)
- Program-driven commercial PV penetration has increased between 2011 and 2016

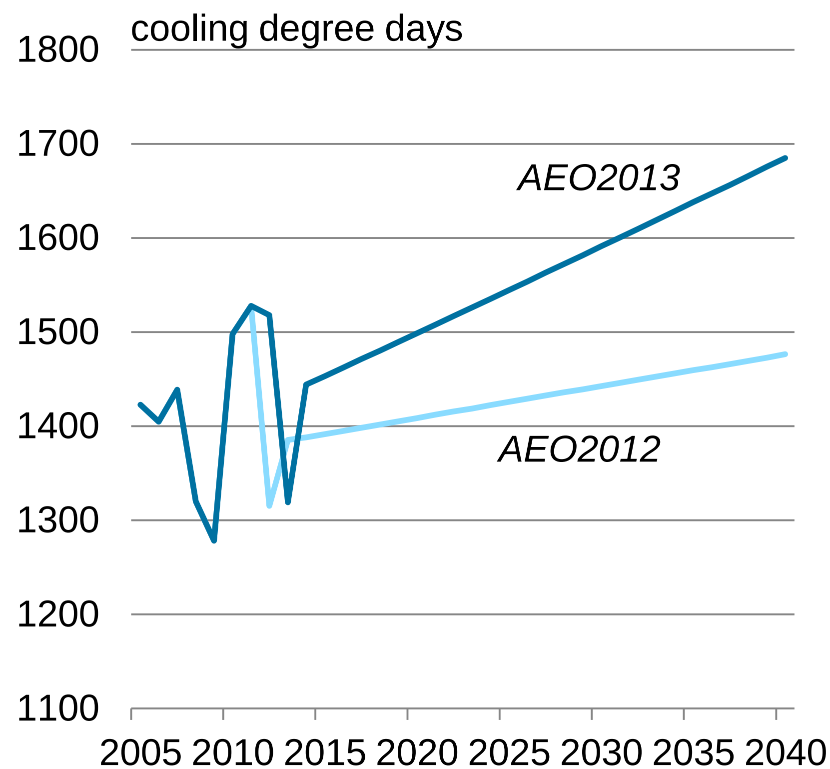
AEO2013 updates result in additional buildings PV capacity



Source: *EIA, Annual Energy Outlook 2013 Early Release, Annual Energy Outlook 2012*

AEO2013 includes a 30-year historical trend for degree day projections





2005 – 2011 = history
2012 – 2013 = recent estimates of history + NOAA near-term forecast
2014 – beyond = EIA projection using 30-year historical trend + population shifts

Source: *EIA, Annual Energy Outlook 2013 Early Release, Annual Energy Outlook 2012*

Degree day projections affect residential and commercial heating and cooling loads

- Applied directly to energy consumption for heating

$$\left(\frac{HDD_{calcyear}}{HDD_{baseyear}} \right)$$

- Cooling adjustment is non-linear

$$\left(\frac{CDD_{calcyear}}{CDD_{baseyear}} \right)^{1.1}$$

For more information

U.S. Energy Information Administration home page | www.eia.gov

Short-Term Energy Outlook | www.eia.gov/steo

Annual Energy Outlook | www.eia.gov/aeo

International Energy Outlook | www.eia.gov/ieo

Monthly Energy Review | www.eia.gov/mer

Today in Energy | www.eia.gov/todayinenergy

Supplemental slides

AEO2013 distributed PV “menu” characteristics

Year of Introduction	Average Generating Capacity (kW_{DC})	Electrical Efficiency	Installed Capital Cost (2009$ per kW_{DC})
Residential			
2010	3.5	0.15	$7,200
2015	4	0.18	$4,965
2025	5	0.20	$3,664
2035	5	0.20	$3,462
Commercial			
2010	30	0.15	$6,410
2015	35	0.18	$4,475
2025	40	0.20	$3,340
2035	45	0.20	$3,151